

6. Claims

1. A defect-inspecting apparatus comprising:

a stage on which an object to be inspected is mounted;

an illumination optical system comprising;

an incident illumination system which

incident-illuminates illumination light including UV light or DUV light at a point on a surface of the object to be inspected, which is mounted on the stage, with desired luminous flux from a normal line direction relative to the surface or from a direction in proximity to the normal line; and

a oblique illumination system which oblique-illuminates illumination light including UV light or DUV light at a point on the surface of the object to be inspected with desired luminous flux;

a detection optical system comprising;

a high-angle image formation optical system which condenses first high-angle scattered light traveling at a high angle relative to the surface of the object to be inspected, from among first reflection light generated from the point, which has been incident-illuminated by the incident illumination system of the illumination optical system, and second high-angle scattered light traveling at the high angle, from among second reflection light generated from the point, which has been oblique-illuminated by the oblique illumination system of the illumination optical system, in order to perform

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image formation; and

a photoelectric conversion unit which receives the first and the second high-angle scattered light, of which image formation has been performed in the high-angle image formation optical system, to convert the first and the second high-angle scattered light into a first and a second luminance signal; and

a comparison and judgment unit which classifies defects on the object to be inspected into concave defects and convex defects on the basis of a correlation between the first luminance signal and the second luminance signal, which have been converted by the photoelectric conversion unit of the detection optical system.

2. A defect-inspecting apparatus according to Claim 1, wherein:

the incident illumination system of the illumination optical system is configured so that stray light is not generated from the high-angle image information optical system.

3. A defect-inspecting apparatus according to Claim 1, wherein:

the detection optical system further comprises a shielding optical element which shields a specific light image, which is caused by the first reflection light, on a Fourier transformed surface of the first reflection light emitted from the point.

4. A defect-inspecting apparatus according to Claim 1,
wherein:

in the comparison and judgment unit, the correlation between the first luminance signal and the second luminance signal is used a ratio between the first luminance signal and the second luminance signal.

5. A defect-inspecting apparatus according to Claim 1,
wherein:

the comparison and judgment unit is configured to classify concave defects into scratches and thin film-like foreign materials on the basis of data in response to a defect size calculated by the first luminance signal and the second luminance signal.

6. A defect-inspecting apparatus according to Claim 1,
wherein:

the comparison and judgment unit is configured to classify foreign materials, which are convex defects, into a small group and a large group on the basis of data in response to a defect size calculated by the first luminance signal and the second luminance signal.

7. A defect-inspecting apparatus according to Claim 1,
wherein:

the comparison and judgment unit is configured to judge that the classified convex defect occurs inside a circuit pattern area, or that the classified convex defect occurs outside the circuit pattern area.

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8. A defect-inspecting apparatus according to Claim 1, wherein:

the comparison and judgment unit has a displaying unit which displays information of defects be classified by the comparison and judgment unit.

9. A defect-inspecting apparatus according to Claim 1, wherein:

the comparison and judgment unit has a displaying unit which displays information about a relation of the first luminance signal to be classified the defects.

10. A defect-inspecting apparatus according to Claim 1, wherein:

the comparison and judgment unit has a displaying unit for displaying information about a relation of the second luminance signal to discriminate a defect.

11. A defect-inspecting apparatus according to Claim 1, wherein:

the comparison and judgment unit has a displaying unit for plotting a relation between the first luminance signal and the second luminance signal, which have been converted by the photoelectric conversion means of the detection optical system, on a correlation diagram, where a horizontal axis and a vertical axis are expressed by logarithm values, to display the relation.

12. A defect-inspecting apparatus according to Claim 1, wherein:

in the illumination optical system, a point incident-illuminated by the incident illumination system and a point oblique-illuminated by the oblique illumination system, which are on the surface of the object to be inspected, are configured to be different from each other in a visual field of the detection optical system.

13. A defect-inspecting apparatus comprising:

a stage on which an object to be inspected is mounted;

an illumination optical system comprising;

an incident illumination system that incident-illuminates illumination light including UV light or DUV light at a point on a surface of the object to be inspected, which is mounted on the stage, with desired luminous flux from a normal line direction relative to the surface or from a direction in proximity to the normal line; and

an oblique illumination system that oblique-illuminates illumination light including UV light or DUV light, which has a wavelength different from that of said incident-illuminated illumination light, at a point on the surface of the object to be inspected with desired luminous flux;

a detection optical system comprising;

a condensing optical system which condenses first high-angle scattered light traveling at a high angle relative to the surface of the object to be inspected, from among first reflection light generated from the point, which has been incident-illuminated by the incident illumination system of

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the illumination optical system, and second high-angle scattered light traveling at the high angle, from among second reflection light generated from the point, which has been oblique-illuminated by the oblique illumination system of the illumination optical system; and

a wavelength separation optical system which wavelength-separates the first high-angle scattered light and the second high-angle scattered light, which have been condensed by the condensing optical system;

an image formation optical system which performs image formation of each of the first high-angle scattered light and the second high-angle scattered light, which have been separated by the wavelength separation optical system; and

a first and a second photoelectric conversion unit which receives each of the first high-angle scattered light and the second high-angle scattered light, for which image formation has been performed by the image formation optical system, to convert the first high-angle scattered light and the second high-angle scattered light into a first luminance signal and a second luminance signal respectively; and

a comparison and judgment unit which discriminates a defect on the object to be inspected on the basis of a relation between the first luminance signal converted by the first photoelectric conversion means and the second luminance signal converted by the second photoelectric conversion means in the detection optical system.

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14. A defect-inspecting apparatus according to Claim 13,
wherein:

the incident illumination system of the illumination optical system is configured so that stray light is not generated from the high-angle condensation optical system.

15. A defect-inspecting apparatus according to Claim 13,
wherein:

the detection optical system further comprises a shielding element which shields a specific light image, which is caused by the first reflection light, on a Fourier transformed surface of the first reflection light emitted from the point.

16. A defect-inspecting apparatus according to Claim 13,
wherein:

in the comparison and judgment unit, ratios are used as the correlation.

17. A defect-inspecting apparatus according to Claim 13,
wherein:

the comparison and judgment unit is configured to classify concave defects into scratches and thin film-like foreign materials on the basis of data in response to a defect size calculated by the first luminance signal and the second luminance signal.

18. A defect-inspecting apparatus according to Claim 13,
wherein:

the comparison and judgment unit is configured to

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classify particulate foreign materials, which are convex defects, into a small group and a large group on the basis of data in response to a defect size calculated by the first luminance signal and the second luminance signal.

19. A defect-inspecting apparatus according to Claim 13, wherein:

the comparison and judgment unit is configured to judge that the classified convex defect occurs inside a circuit pattern area, or that the classified convex defect occurs outside the circuit pattern area.

20. A defect-inspecting apparatus according to Claim 13, wherein:

the comparison and judgment unit has an displaying means for displaying information of a discriminated defect.

21. A defect-inspecting apparatus according to Claim 13, wherein:

the comparison and judgment unit has a displaying means for displaying information about a relation of the first luminance signal to discriminate a defect.

22. A defect-inspecting apparatus according to Claim 13, wherein:

the comparison and judgment unit has a displaying means for displaying information about a relation of the second luminance signal to discriminate a defect.

23. A defect-inspecting apparatus according to Claim 13, wherein:

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the comparison and judgment unit has a displaying means for plotting a relation between the first luminance signal and the second luminance signal, which have been converted by the photoelectric conversion means of the detection optical system, on a correlation diagram, where a horizontal axis and a vertical axis are expressed by logarithm values, to display the relation.

24. A defect-inspecting method comprising the steps of:

incident-illuminating and oblique-illuminating illumination light including UV light or DUV light on a shallow scratch and a foreign material, which are made on a surface of a polished or a ground film, with substantially the same luminous flux;

receiving scattered light caused by the shallow scratch and the foreign material by a detector, said scattered light being generated by the incident illumination and the oblique illumination, to convert the scattered light into luminance signals in response to each intensity of the scattered light; and

discriminating between the shallow scratch and the particulate foreign material on the basis of a correlation of the converted luminance signals.

25. A defect-inspecting method comprising the steps of:

incident-illuminating and oblique-illuminating illumination light including UV light or DUV light on a flat thin film-like foreign material and a foreign material, which

are made on a surface of a polished, washed, or a sputtered film, with substantially the same luminous flux;

receiving scattered light caused by the thin film-like foreign material and the foreign material by a detector, said scattered light being generated by the incident illumination and the oblique illumination, to convert the scattered light into luminance signals in response to each intensity of the scattered light; and

discriminating between the thin film-like foreign material and the particulate foreign material on the basis of a correlation of the converted luminance signals.

26. A defect-inspecting method comprising the steps of:
an illumination step for

incident-illuminating illumination light including UV light or DUV light at a point on a surface of an object to be inspected, which is mounted on a stage, with desired luminous flux from a normal line direction relative to the surface or from a direction in proximity to the normal line, using an incident-illuminating system; and

oblique-illuminating illumination light including UV light or DUV light at a point on the surface of the object to be inspected with desired luminous flux, using a oblique-illuminating system;

a detection step for

condensing first high-angle scattered light traveling at a high angle relative to the surface of the object to be

inspected, from among first reflection light generated from the point, which has been incident-illuminated by the illumination step, and second high-angle scattered light traveling at the high angle, from among second reflection light generated from the point, which has been oblique-illuminated by the illumination step, using a high-angle image formation optical system in order to perform image formation; and

receiving the first high-angle scattered light and the second high-angle scattered light, for which image formation have been performed, using a photoelectric conversion means to convert the first high-angle scattered light and the second high-angle scattered light into a first and a second luminance signal; and

a comparison and judgment step for classifying defects on the object to be inspected into concave defects and convex defects on the basis of a correlation between the first luminance signal and the second luminance signal, which have been converted by the detection step.

27. A defect-inspecting method comprising the steps of:
an illumination step for

incident-illuminating illumination light including UV light or DUV light at a point on a surface of an object to be inspected, which is mounted on a stage, with desired luminous flux from a normal line direction relative to the surface or from a direction in proximity to the normal line, using an

incident-illuminating system; and

oblique-illuminating illumination light including UV light or DUV light, which has a wavelength different from that of said incident-illuminated illumination light, at a point on the surface of the object to be inspected with desired luminous flux using a oblique illumination system;

a detection step for

condensing first high-angle scattered light traveling at a high angle relative to the surface of the object to be inspected, from among first reflection light generated from the point, which has been incident-illuminated by the illumination step, and second high-angle scattered light traveling at the high angle, from among second reflection light generated from the point, which has been oblique-illuminated by the illumination step, using a condensing optical system;

wavelength-separating the first high-angle scattered light and the second high-angle scattered light, which have been condensed, using a wavelength separation optical system;

performing image formation for each of the first high-angle scattered light and the second high-angle scattered light, which have been wavelength-separated, using an image formation optical system; and

receiving each of the first high-angle scattered light and the second high-angle scattered light, for which image formation has been performed, using a first and a second

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photoelectric conversion means to convert the first high-angle scattered light and the second high-angle scattered light into a first luminance signal and a second luminance signal respectively; and

a comparison and judgment step for discriminating a defect on the object to be inspected on the basis of a correlation between the first luminance signal converted by the detection step and the second luminance signal converted by the second photoelectric conversion means.

28. A method for producing a semiconductor device comprising the steps of:

a fabrication process for polishing or grinding an object surface of a semiconductor device;

a defect inspection process for incident-illuminating and oblique-illuminating illumination light including UV light or DUV light on a shallow scratch and a foreign material, which have been made on the object surface polished or ground by the fabrication process, with substantially the same luminous flux;

receiving scattered light caused by a shallow scratch and a foreign material by a detector, said scattered light being generated by the incident illumination and the oblique illumination, to convert the scattered light into luminance signals in response to each intensity of the scattered light; and

discriminating between the shallow scratch and the

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particulate foreign material on the basis of a correlation of the converted luminance signals; and

a feedback process for supplying the fabrication process with information of the shallow scratch and the particulate foreign material, which have been discriminated in the defect inspection process, as feedback.

29. A method for producing a semiconductor device comprising the steps of:

a fabrication process for polishing, washing, or sputtering an object surface of a semiconductor device;

a defect inspection process for incident-illuminating and oblique-illuminating illumination light including UV light or DUV light on a flat thin film-like foreign material and a foreign material, which have been made on the object surface polished, washed, or sputtered by the fabrication process, with substantially the same luminous flux;

receiving scattered light caused by the thin film-like foreign material and the foreign material by a detector, said scattered light being generated by the incident illumination and the oblique illumination, to convert the scattered light into luminance signals in response to each intensity of the scattered light; and

discriminating between the thin film-like foreign material and the particulate foreign material on the basis of a correlation of the converted luminance signals; and

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a feedback process for supplying the fabrication process with information of the thin film-like foreign material and the particulate foreign material, which have been discriminated in the defect inspection process, as feedback.

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